Antiproton and Proton Corrections for the TPC at STAR

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In ultrarelativistic heavy ion collisions at RHIC energies, more than 4000 charged particles are produced in the most violent collisions. The STAR detector with its large Time Projection Chamber (TPC)[1] measures these particles at full azimuthal coverage in the pseudorapidity interval $|\eta| \leq 2$. For comparison with theoretical predictions, correction for finite acceptance and tracking efficiency of the TPC data is essential.

Correction factors were determined by embedding Monte Carlo tracks to the experimental data set originating from the primary vertex position. For a particular particle species, the number of embedded tracks was 5% of the total number of tracks in the real event, restricting the perturbation of the real event to the level of statistical fluctuations within the event sample. A flat distribution in tansverse momentum p_t and pseudorapidity η was chosen, with $0 < p_t < 2$ GeV/c and $-1.2 < \eta < 1.2$. Tracking of charged particles was performed using the GEANT Monte Carlo code taking into account the full geometry of the STAR detector setup.[2] The response of the TPC to these tracks was calculated, using a realistic microscopic simulation of the TPC. Subsequently, the resulting detector signals were embedded to the real event data at the raw data level. From embedded data, the correction is defined by the ratio of the number of tracks reconstructed to the number of tracks embedded. This is shown in Fig. 1 for antiprotons as a function of transverse momentum p_t in the rapidity bin $|y| < 0.1$ and 5% most central collisions. The correction can be understood as a product of acceptance, which is basically a geometrical factor, and the efficiency of the tracking routines to find particle tracks inside the TPC. For $p_t < 0.4$ GeV/c the correction is a steeply rising function due to finite acceptance and particle absorption in the detector material. At larger p_t the correction is dominated by the tracking efficiency
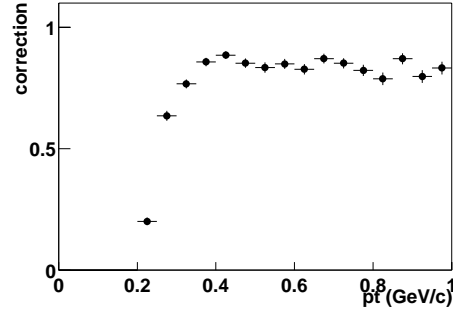

Figure 1: *Correction for antiprotons in the rapidity interval $|y| < 0.1$ and 5% most central collissions.*

and turns out to be rather independent of p_t. Due to the decreasing track density, the correction rises linearly by 15% (absolute) from most central collisions to periphal collisions. In comparison to protons, the correction for antiprotons is at $p_t > 0.6$ GeV/c identical, and decreases linearly up to 15% (relative) at $p_t = 0.25$ GeV/c. This is due to annihilation of antiprotons in the detector material.

The resolution in tranverse momentum is estimated by comparing the reconstructed momentum to the initial momentum of the Monte Carlo track. This is shown in Fig. 2, where the momentum resolution is strongly deteriorating with decreasing momentum due to multiple scattering dominating the momentum resolution at $p_t < 0.4$ GeV/c.
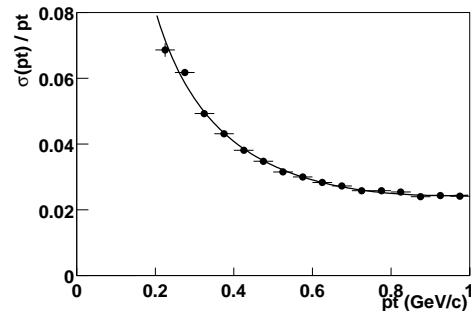

Figure 2: *Resolution σ in transverse momentum p_t for antiprotons in the rapidity interval $|y| < 0.5$. The solid line is an empirical fit to the points.*

Footnotes and References

[1] J. Harris, (STAR Collaboration) *'Quark Matter 2001 Proceedings'*, Stony Brook, January 15-20, 2001, F. Retiere, (STAR Collaboration) *'Quark Matter 2001 Proceedings'*, Stony Brook, January 15-20, 2001.

[2] P. Nevski, *Proceedings of the International Conference on Computing in High Energy and Nuclear Physics*, Padova, Italy, 2000.